MONITORING NETWORK PERFORMANCE USING INDIVIDUAL CELL PHONE LOCATION AND PERFORMANCE INFORMATION

Cross Reference to Related Applications

This application claims the benefit under 35 U.S.C. Section 119(e) to Provisional Application No. 60/173,614, filed December 29, 1999, the contents of which are incorporated herein by referenced.

Field of the Invention

The present invention relates to mobile communications systems and, more specifically, to a system for optimizing performance of a mobile communications system.

Background of the Invention

Figure 1 shows a block diagram of a conventional cellular radiotelephone communication system 5 which includes cells 6, radio base stations or cell sites 8, and a Mobile Telephone Switching Office (MTSO) or mobile telephone switching center 9. As a mobile telephone customer 7 moves from one cell to another, a switch in the MTSO 9 automatically switches connections with the respective radio base stations 8 to maintain a continuous connection with the public switched network (not shown). Typically, a switch in a Mobile Switching Telephone Office is connected to approximately one hundred cell sites.

A problem associated with the management of a cellular radiotelephone communications system is geographically locating an area within the zone of radio coverage or cell where faulty coverage exists. For example, an area within a cellular telephone system may provide poor service due to moderate levels of interference. Typically, this situation is discovered through customer complaints or a persistent drive team testing by system operators. Neither of these

approaches, however, provides very timely or comprehensive means of identifying, diagnosing, and curing faulty coverage.

In response to these deficiencies, the cellular industry has turned to the aid of electromagnetic coverage prediction tools to assist in the search for holes in the coverage. Typically, such methods of monitoring system performance include observing downlink information along with other system parameters. The term "downlink" meaning signals travelling from the cell site to the mobile unit and "uplink" meaning signals travelling from the mobile unit to the cell site. Observing the downlink connection provides evidence of the status of the uplink connection. The assumption is that if the downlink was closed (i.e., a good connection was attained), the available uplink power would be sufficient to close the uplink.

SUMMARY OF THE INVENTION

The present invention generally comprises a method and system for monitoring the performance of a wireless telecommunications system. The preferred embodiment involves a method and system of evaluating the coverage of a geographic area serviced by a mobile communications system.

An aspect of the present invention includes a method of monitoring performance of a wireless system. The method comprises transmitting a communication signal from a wireless device to a radio base station; obtaining uplink performance parameters associated with the communication signal; obtaining location information of the wireless device by analyzing the communication signal; and evaluating the performance of the wireless system using the uplink performance parameters and the location information of the wireless device.

Another aspect of the present invention includes a method of monitoring performance of a wireless system. This method comprises transmitting a communication signal from a plurality

of wireless devices to a radio base station; obtaining uplink performance parameters associated with the communication signals; obtaining location information of the plurality of wireless devices by analyzing the communication signal; and evaluating the performance of the wireless system using the uplink performance parameters and the location information of each of the plurality of wireless devices.

Another aspect of the present invention includes a system for monitoring performance of a wireless system, the system comprises: a plurality of wireless devices which transmit communications signals to a radio base station; a first receiver located at the radio base station which receives the communication signals and transmits the communication signals to a switch; a second receiver located at the radio base station which monitors the communication signals and transmits timestamp data associated with the communication signals to the switch; and a system analyzer coupled to the switch which evaluates the performance of the wireless system based on uplink performance parameters and the location of the wireless devices.

Another aspect of the present invention includes a system for monitoring performance of a wireless system, this system comprises: a plurality of wireless devices which transmit communications signals to a radio base station; a first means for receiving the communication signals and transmitting the communication signals to a switch; a second means for monitoring the communication signals and transmitting timestamp data associated with the communication signals to the switch; and a system analyzer coupled to the switch which evaluates the performance of the wireless system based on uplink performance parameters and the location of the wireless devices.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention may be understood with reference to the attached drawings and accompanying description, in which:

Figure 1 is a block diagram of a conventional radiotelephone system;

Figure 2 is a block diagram of a system for optimizing a mobile communication system according to a preferred embodiment; and

Figure 3 is a flow chart illustrating a method according to an aspect of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

In the preferred embodiment, call data collected from the switch at the Mobile Telephone Switching Office (MTSO) or mobile switching center is combined with location information of a wireless device to generate information reports concerning the signal coverage of a geographic region.

Collecting call data from the switch at the switching center permits consideration of uplink and also downlink information in the analysis of system performance. The uplink information reflects performance of specific equipment currently used by the wireless customer. This uplink information may be combined with location information to remove from the performance evaluation transient effects associated with, for example, local terrain and other physical impairments.

Figure 2 is a diagram of a communication system 10 illustrating a preferred embodiment of the present invention. Since it is understood by those skilled in the art that other components

and devices are typically included in this embodiment, only those pertinent to the preferred embodiment will be discussed.

As shown in Figure 2, a plurality of wireless devices 12 surrounds a radio base station 16 to form a cell. The plurality of wireless devices 12 may include cellular telephones, computers, personal communication systems, paging devices, or some other type of communication device. This discussion uses the term "cellular" to indicate any type of mobile communication system – analog or digital – which divides a region into geographic areas (cells) and involves handing off of the mobile unit as it moves from cell to cell. Although any type of mobile communication device may be used as the wireless device 12, the use of a digital device would provide the most information.

Each cell site serving one of the plurality of wireless devices 12 moving through the cellular system are connected to local switches. The plurality of wireless devices 12 transmits a signal to an antenna 17 at a radio base station (RBS) 16. Two receivers 17A and 17B are associated with antenna 17. The first receiver 17A is a standard receiver that forwards the call through a standard link 19 to a local voice data network switch 18. The second receiver 17B is part of a signal collection system that will determine the location of the wireless devices. The second receiver 17B is different than most existing cell site receivers because it scans all of the radio channels simultaneously and utilizes highly accurate timing clocks. An example of such a system is the TruePosition™ system. These systems precisely time the radio signals that are transmitted from the wireless device to various cell sites. A technique known as Time Difference of Arrival (TDOA) is used to calculate a wireless device's location, speed and direction of travel. More specifically, when the radio waves from one of the wireless devices 12 reach the signal collection systems receiver 17B installed at the RBS 16, the software associated

with receiver 17B records a very precise timestamp. Once the signal has been timestamped, the timestamp information is collected and transmitted through link 19 to switch 18.

Other means to determine wireless device location may include providing part of a GPS receiver with the handset; using a TDOA technique to measure data at the handset rather than switch 19; and using RF finger printing wherein the dispersion characteristics of the radio signal are used to determine location. Therefore, the specific manner of determining the location of the wireless device 12 is not important or limiting in the present invention.

The switch 18 collects the call data and the timestamp information and forwards the call data directly over a standard link 21 to a base unit 27. The base unit 27 may or may not be located at the switch 18 and link 21 may, for example, be a voice line or a Local Area Network (LAN). The base 27 unit, using a system analyzer 29 such as a personal computer (PC), performs call data and location data analysis.

In the preferred embodiment, the call data is collected on the uplink at the switch 18 using Cell Traffic Recording (CTR) software. CER is a software function provided to users of an Ericsson mobile telephone switch. CER describes aspects of the call in a text format. This function allows real-time tracing of the activities of a phone call in progress. Although the preferred embodiment is directed to an Ericsson switch, other switching devices using software other than CER may be used.

The call data parameters collected at the switch 18 may include, but are not limited to, the following: Forward and Reverse (or Received) Signal Strength Indication (SSI); Forward and Reverse Bit Error Rate (BER); Time Alignment; Frequency Error; Power Level of Mobile (PLM) Unit; Frequency Group; Channel; Voice Channel Group; Mobile Device Identification

Number; Mobile Manufacturer Number; and Mobile Assisted Handoff (MAHO) information which may include data on neighboring cell sites as well.

Therefore, the preferred embodiment allows a system evaluator located at the PC 29 to take advantage of information from the switch 18 to analyze the service provided each of the calls from the wireless devices. The preferred embodiment allows for the performance of two types of analysis. The first one is real-time analysis that occurs during use of the wireless devices 12. The second type of analysis is post-processing analysis which occurs after completion of the operation of the wireless device 12.

Currently, the call data collected at the switch 18 contains almost all of the important information about the parameters of a call but cannot provide the current location of the wireless devices 12 that are being monitored to determine where a problem in coverage is occurring. Without the location of the wireless device much of the data collected is irrelevant. An example of an electromagnetic diagnostic tool which incorporates location information in the analysis is found in U.S. Patent Application Serial No. 08/996,486, filed on December 23, 1997, commonly assigned and which is hereby incorporated by reference. This diagnostic tool features a PC equipped with a global positioning satellite (GPS) system which transmits location data of the wireless device while a call is in progress. However, this is an expensive and inefficient system because it requires a PC separate from the wireless device and allows for only one call to be analyzed at a time.

In the preferred embodiment, also located near the switch 18, is a TDOA Location Processor 25. The TDOA Location Processor may be an array of digital signal processors that perform all of the location processing for an entire cellular system. TDOA and geolocation algorithms monitor an entire wireless network. The timestamp differences are collected from the

switch 18 through link 23a and are calculated to geometrically form hyperbolae that then intersect at or near the true location of the wireless device. The location information is then forwarded to the PC 22 through link 23b where analysis is performed matching the location of the wireless device with the call data parameters to monitor performance of the cell. The performance may then be analyzed and adjustments to the cell site may be made. For example, adjustments include changing the down tilt of the antenna 17 to take energy off the horizon or increasing or decreasing the power of the antenna. System evaluators have agreed on certain goals that must be achieved by the system parameters such as a specific set of RSSI level break points, BER thresholds forward and reverse, etc., that are a requirement for a cell site. The mobile communications analysis of the preferred embodiment may be used to expedite service improvements and to determine future build plans.

An advantage of the preferred embodiment is that the number of wireless devices that may be analyzed is only limited by the capability of the cell site. Thousands of calls may be simultaneously monitored when configuring a cell site.

Figure 3 illustrates an exemplary process for monitoring performance of a wireless system according to an aspect of the present invention. The method comprises a) transmitting a communication signal from a wireless device to a radio base station (50); b) obtaining uplink performance parameters associated with the communication signal (52); c) obtaining location information of the wireless device by analyzing the communication signal (54); and d) evaluating the performance of the wireless system using the uplink performance parameters and the location information of the wireless device (56).

Variations on the method shown in figure 3 include evaluating the performance of the wireless system is performed in real-time and collecting the location information of the wireless

device from a plurality of radio base stations. Furthermore, there may be variations in how the step of obtaining the location information (54) is carried out. For example, obtaining location information may further comprise analyzing timestamp data or may involve using a TDOA Location Processor.

The method according to an aspect of the present invention may involved transmitting communication signals from either a single wireless device 12 or from a plurality of wireless devices. If a plurality of wireless devices 12 transmit communication signals, then the remaining steps in the method aspect of the invention also operate accordingly. For example, the uplink performance parameters (52) are obtained for all the communication signals and the location information for all the wireless devices is obtained (54) and the evaluation of the performance of the wireless system using the uplink performance parameters and the location information is performed for each of the plurality of wireless devices.

The above-described embodiment is illustrative of the principles of the present invention. Various modifications and changes may be devised by those skilled in the art without departing from the spirit and scope of the invention as set forth in the appended claims.